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(54) SPLINED SHAFT SEAL ARTICLE AND APPARATUS

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SPLINED SHAFT SEAL ARTICLE AND APPARATUS

ABSTRACT

A seal 10 for sealing between a splined shaft 30 and a housing 32 having a bore 34 through which the splined shaft 30 extends. The seal 10 includes a shell 12 and an elastomeric body 14 bonded thereto. The body 14 includes a mounting portion 16 and a toothed seal portion 18 having a plurality of seal teeth 42 that are matingly received in the grooves 48 in the splined shaft. The seal teeth 42 are molded to provide interference "y" at the top and bottom of the teeth 42 and interference "x" at the sides; $x \geq 150\%$ y. The seal 10 also has a seal 24 to seal against the housing 32.

SPLINED SHAFT SEAL ARTICLE AND APPARATUS

TECHNICAL FIELD

This invention relates to seals and in particular to a seal for use between the splined portion of a shaft and a housing having a bore through which the shaft extends in relative reciprocating movement.

BACKGROUND OF THE PRIOR ART

Current seal designs are made with a non-elastomeric element which, under tension, takes a permanent set consequently losing the initial interference with the splined teeth. Further, an expensive thread operation is provided on these designs in order to hold the seal in position on the housing. However, the metal to metal threads do not provide for a positive seal between the seal and the housing. This type of previous seal is also easily damaged during installation and one or more of the component parts can become lost due to the loose assembly. These current dust cap seals are three piece seals consisting of: (1) an outer case, (2) an inner retainer ring with the approximate shape of the splined teeth, and (3) the sealing element itself, which is usually cork or felt material. This type of seal offers very little sealability due to the materials used and the construction of the sealing areas. The three piece construction affects the assembly operation by making it more difficult and leak paths can occur through the mating surfaces of the constructed pieces. Lip type seals are also used in splined shaft applications, however, they cannot seal in the splined area so they are limited in use to a smooth surface adjacent to the splined area. In most applications, the splined section of the shaft must pass through the lip of the seal

during installation and this can result in damage to the seal.

It is an object of the present invention to provide an improved splined shaft seal that overcomes the problems mentioned above that are inherent in the prior art seals. It is a further object of the present invention to provide a splined shaft seal having an elastomeric element that is not easily damaged during installation and that is designed to either press on or screw on the spline housing without having first been pushed over the splined shaft. It is another object of the present invention to provide such a seal having elastomeric teeth adapted to mate with the grooves in the splined shaft and having an interference that provides proper sealing. It is another object of the present invention to provide a positive seal between the seal and the housing through which the splined shaft extends.

BRIEF SUMMARY OF THE INVENTION

In one aspect the invention pertains to an annular seal for a splined shaft comprising an annular metal shell and a molded elastomeric body. The body includes a mounting portion bonded to the shell for mounting the seal on a housing, the mounting portion including an annular elastomeric seal adapted to contact a surface of a housing when the seal is mounted on a housing to provide a seal therebetween. The body also includes an annular toothed seal portion having a plurality of identical, circumferentially equally spaced-apart, radially inwardly extending seal teeth separated by a plurality of identical grooves, each of the teeth having side walls tapering from a wider width at their base to a narrower width at their top.

More particularly the invention pertains to a splined shaft seal and apparatus including a splined shaft, a housing

having a bore through which the shaft extends, and the above seal for sealing between the splined shaft and the housing. The seal teeth are molded with a size so as to provide, when installed on a splined shaft, an interference "y" between the top of the spline teeth and the base of the seal groove, and an interference "x" between each side of the seal teeth and the spline teeth. Further, according to a preferred aspect, $x \geq 150\%\ y$, and in a most preferred embodiment, x is about three times as great as y.

The mounting portion of the seal can include internal molded, elastomeric screw threads for mating with external screw threads on the O.D. of the housing, or can include an annular, radially inwardly extending rib having a radial shoulder facing axially outwardly and adapted to be snap-locked over an annular radial shoulder on the housing facing axially inwardly. In addition, the seal mounting portion includes means for providing a seal between the seal and the housing, including an additional elastomeric seal facing axially inwardly and adapted to contact a radial surface of the housing when the seal is mounted thereon. In addition, the elastomeric part of the seal can be two separate pieces including a mounting portion bonded to the shell and a separate toothed seal portion that can rotate relative to the mounting portion to aid in installation.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be more fully understood by reference to the following detailed description thereof, when read in conjunction with the attached drawings, wherein like reference numerals refer to like elements and wherein:

Fig. 1 is a cross-sectional partial view through a seal according to a preferred embodiment of the present invention;

Fig. 2 is a partly cross-sectional view through an apparatus according to the present invention including a splined shaft, a housing such as a slip yoke and a seal as shown in Fig. 1;

Fig. 3 is a partial cross-sectional view along line 3-3 in Fig. 2;

Fig. 4 is a cross-sectional partial view of a seal according to another embodiment of the present invention; and

Fig. 5 is a cross-sectional, partial view of a seal according to a still further embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

With reference now to the drawings, Fig. 1 shows a seal 10 according to a preferred embodiment of the present invention. The seal 10 includes an annular metal shell 12 and a molded annular elastomeric body 14 bonded to the shell 12. The elastomeric body 14 includes a mounting portion 16 and an annular toothed seal portion 18 (described in more detail below with respect to Fig. 3).

The mounting portion 16 includes an annular, radially inwardly extending rib 20 having a shoulder 22 (preferably at an angle of about 45° to a plane perpendicular to the seal axis) adapted to lock the seal 10 onto the housing (as described in more detail below with respect to Fig. 2). The mounting portion also includes means for providing a seal between the seal 10 and a housing (see housing 32 in Fig. 2). This sealing means includes an annular elastomeric seal 24 facing axially inwardly (the direction "axially inwardly" is hereby defined for use in the present specification and claims to mean the direction vertically down in Fig. 2, that is, the direction into the housing 32, and the term "axially outwardly" means the opposite direction, i.e. vertically up in Fig. 2). The

seal 24 is adapted to contact a radial surface 40 of the housing 32 when the seal 10 is mounted thereon (see Fig. 2). The seal 24 is formed on a surface 26 which extends substantially radially inwardly and axially inwardly at an acute angle "α" to a plane perpendicular to the seal axis. According to the present invention $\alpha \geq 10°$.

Fig. 2 shows the seal 10 as installed for sealing between the splined end 28 of a shaft 30 and a housing 32 such as a slip yoke. In this particular embodiment, the housing 32 has a bore 34 therein having grooves 36 in the bore 34 of a size and shape adapted to matingly receive the splined end 28 of the shaft 30 which is mounted for relative reciprocating movement in the housing bore 34. The seal 10 seals between the splined end 28 and the housing 32 by means of the toothed seal portion 18 (described in detail below with reference to Fig. 3). The housing 32 includes on its O.D. surface an annular radial shoulder 38 facing axially inwardly for snap-locking engagement with the shoulder 22 on the rib 20 of the seal 10. The shoulder 38 can be on a annular rib or flange as shown in Fig. 2 or it can be in an annular groove formed in the O.D. of the housing 32. The mounting portion 16 of the seal 10 is sized such that when the shoulder 22 thereof is in locking engagement with the shoulder 38, the seal 24 is in sealing contact or engagement with the front radial surface 40 of the housing 32, to provide a seal between the seal 10 and the housing 32.

Fig. 3 is an enlarged partial cross-sectional view along line 3-3 in Fig. 2 showing the mating engagement between the splined end 28 of the shaft 30 and the toothed seal portion 18 of the seal 10. As shown in Fig. 3, the

seal 10 includes a plurality of identical, circumferentially equally spaced-apart, radially inwardly extending seal teeth 42 separated by a plurality of identical grooves 44. The splined end 28 of the shaft 30 includes a plurality of identical, circumferentially equally spaced-apart, radially outwardly extending spline teeth 46. The seal 10 has an as-molded shape and size shown by the dotted line in Fig. 3. The seal 10 when it is installed onto the splined end 28 of the shaft stretches radially outwardly and circumferentially so as to fit over the splined end 28. Thus, Fig. 3 shows (by virtue of the dotted line) the designed interference as will be understood by one skilled in the art. According to the present invention, to provide the interference required for improved or optimum seal, the "x" dimension should be greater than or equal to 150% of the "y" dimension. During installation, the seal stretches outwardly, however, since the body 14 is a synthetic rubber or elastomer it is essentially a hydraulic fluid which is not compressible but it is displaceable. According to the present invention, the rubber that is displaced when the seal teeth 42 are forced into the groove 48 of the shaft 30, is moved radially inwardly so as to fill the bottom of the groove 48 and provide the desired interference both at the bottom of the grooves and at the sides thereof.

Fig. 4 shows a seal 52 according to another embodiment of the present invention, which is identical to the seal 10 in Fig. 1 except that the elastomeric mounting portion 54 is provided with molded-in screw threads 56 adapted to mate with corresponding screw threads on the O.D. of a housing. In this embodiment, the seal 52 simply is screw threaded onto a housing until the seal 24 is in sealing engagement with the surface 40 of the housing.

Fig. 5 shows another embodiment of the present invention of a seal 60 which is similar to that shown in

Fig. 1 except that the seal 60 has a two-part elastomeric body including a mounting portion 62 bonded to a shell 66, and a separate elastomeric, toothed seal portion 64. The two portions are molded separately and then the toothed portion 64 is installed into the mounting portion 62. The mounting portion 62 can have either a screw threaded surface as shown in Fig. 4 or it can include a snap-lock configuration as shown in Fig. 1. The toothed portion 64 is sufficiently free to allow the mounting portion 62 to be threaded (or snap-locked) onto the housing prior to installation therethrough of the shaft 30, that is, the portion 64 can be rotated to mesh with the shaft. The mounting portion 62 has a cylindrical part and a radial flange extending radially inwardly and the seal portion 64 includes a cylindrical part and a radial flange extending radially outwardly. The I.D 72 of the radial flange of the mounting portion 62 is substantially equal to the O.D. 68 of the cylindrical part of the seal portion 64, and the I.D. 74 of the cylindrical part of the mounting portion 62 is substantially equal to the O.D. 70 of the radial flange of the seal portion 64.

In one preferred embodiment, the splined end 28 has an O.D. of 1.372 inch and a spline I.D.of 1.064 inch. The toothed seal portion 18 of the as-molded seal 10 has an O.D. of 1.363 inch and an I.D. of 1.053 inch. Thus, the value of y at the top of the spline teeth 46 was .0045 inch and the value y at the bottom is substantially the same or .0055 inch. In this embodiment, $x = .014$ inch. Further, the width of the grooves 44 was .120 inch, there were 16 teeth 42, and the housing 32 was a slip yoke and the shaft 30 was a propeller shaft tube having a splined end 28.

The seal of the present invention can be mounted to the housing other than on its O.D., such as on an I.D. or on the end thereof, and can be used with a housing having

a bore larger than the O.D. of the splined shaft (that is, on a housing not having mating grooves 36).

The invention has been described in detail with particular reference to the preferred embodiments thereof, but it will be understood that variations and modifications can be affected within the spirit and scope of the invention as described hereinafter and as defined in the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An annular seal for a splined shaft comprising:

(a) an annular metal shell;

(b) a molded elastomeric body;

(c) said body including a mounting portion bonded to said shell for mounting said seal on a housing, said mounting portion including an annular elastomeric seal adapted to contact a surface of a housing when said seal is mounted on a housing to provide a seal therebetween; and

(d) said body also including an annular toothed seal portion having a plurality of identical, circumferentially equally spaced-apart, radially inwardly extending seal teeth separated by a plurality of identical grooves, each of said teeth having side walls tapering from a wider width at their base to a narrower width at their top.

2. The annular seal according to claim 1 wherein said body is a unitary molded elastomeric body.

3. The annular seal according to claim 2 wherein said mounting portion has an I.D. surface adapted to mount on an O.D. surface of a housing.

4. The annular seal according to claim 3 wherein said seal mounting portion includes molded screw threads on said I.D.

surface for engaging external screw threads on the O.D. of a housing.

5. The annular seal according to claim 4 wherein said mounting portion includes an annular, radially inwardly extending rib having a shoulder facing axially outwardly, said shoulder being adapted to snap-lock against an axially inwardly facing shoulder on a housing.

6. The annular seal according to claim 5 wherein said annular elastomeric seal is formed on a surface extending radially inwardly and axially inwardly at an acute angle α to a plane perpendicular to the seal axis, and wherein $\alpha \geq 10°$.

7. The annular seal according to claim 6 wherein said seal teeth are molded with an interference y at said teeth grooves, and with an interference x at each side of said seal teeth, and wherein $x \geq 150\%\ y$.

8. The annular seal according to claim 7 wherein said seal teeth are also molded with an interference substantially equal to y at their top.

9. An annular seal for a splined shaft comprising:

(a) an annular metal shell;

(b) a pair of separate, molded, annular elastomeric portions including a mounting portion bonded to said shell for mounting said seal on a housing, and an annular toothed seal portion;

(c) said mounting portion including a cylindrical part and a radial flange extending radially inwardly and said seal portion including a cylindrical part and a radial flange extending radially outwardly, the I.D. of the radial flange of the mounting portion being substantially equal to the O.D. of the cylindrical part of the seal portion, and the I.D. of the cylindrical part of the mounting portion being substantially equal to the O.D. of the radial flange of the seal portion; and

(d) said seal portion having a plurality of identical, circumferentially equally spaced-apart, radially inwardly extending seal teeth separated by a plurality of identical grooves, each seal tooth fitting in a respective groove of said splined shaft in sealing contact therewith, and said seal teeth having sidewalls tapering from a wider width at their base to a narrower width at their top.

10. The apparatus according to claim 9 wherein said seal teeth have an interference "y" between the top of the spline teeth and the groove of the seal teeth and have an interference "x" between each side of the spline teeth and the seal teeth, and $x \geq 150\%\ y$.

11. The apparatus according to claim 10 wherein said seal teeth also have an interference between the top of the seal teeth and the bottom of the groove of the spline teeth of substantially y.

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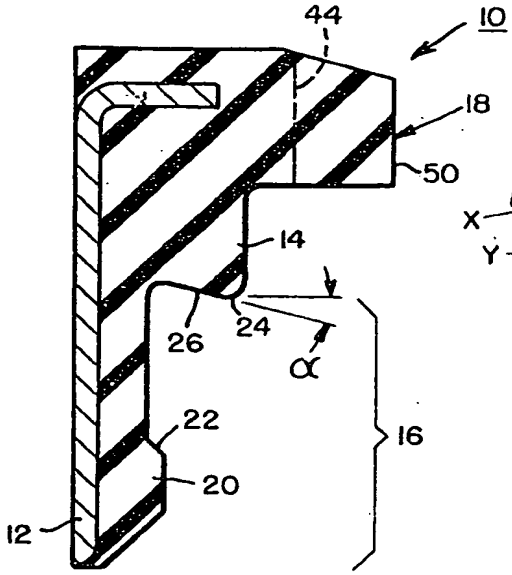

FIG. 1

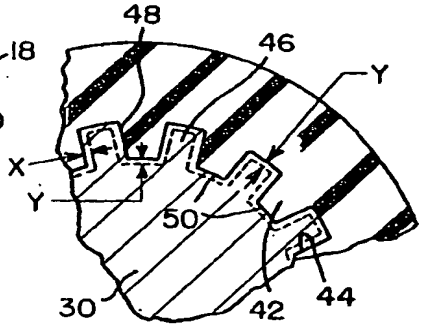

FIG. 3

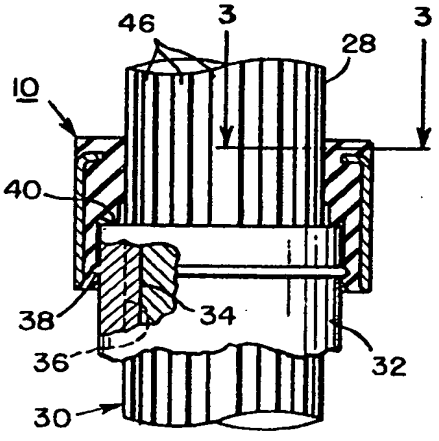

FIG. 2

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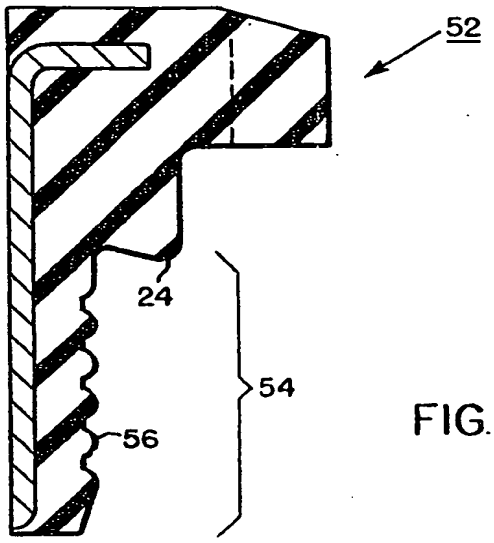

FIG. 4

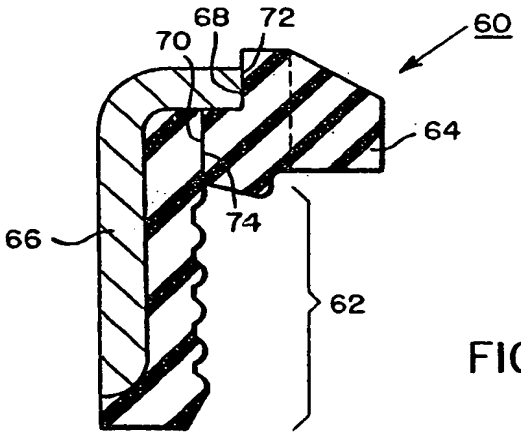

FIG. 5

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